

## Addressing multicomponent complexity in freeze structuring of food colloids

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Freeze structuring (FS) is a promising technique for engineering porous food structures through controlled ice crystal formation. FS's scalable, straightforward process enables precise control over pore morphology by manipulating ice crystal formation in suspensions through material and process parameters. However, food systems are inherently complex, heterogeneous, and polydisperse mixtures of polysaccharides, proteins, and fats. Unlike well-studied single-component systems, the interactions within multi-component mixtures during FS are challenging, limiting the broader adoption of FS for food systems (1).

In this work, we investigate how material parameters influence structural outcomes across scales, from microscale porosity to macroscale mechanical properties. We focus on solid loading and water–material interactions as key drivers of structure formation and propose viscosity as an accessible, potentially predictive parameter for morphology control. By enabling the direct structuring of complex food mixtures without pre-purification, we aim to position FS as a practical tool for efficient, nutritious, and scalable food design.

### Keywords:

freeze structuring, food colloids, proteins, polysaccharides, rheology



*Freeze structured variety of food products - from cream cheese to broccoli*

### References:

(1) Bach, A.; Rühls, P. A. Addressing Multifactorial Complexity in Freeze Structuring of Food Colloids. *Curr. Opin. Colloid Interface Sci.* **2025**, 101941. <https://doi.org/10.1016/J.COCIS.2025.101941>